LEAVES FROM THE NOTE-BOOK OF A BELLEVUE NURSE

LECTURE V.—(Continued)

(Continued from page 927)

Bile.—The bile, which also forms part of the intestinal juices, is partly an excretion. It is golden-brown in color, alkaline, and viscid. It is secreted by the liver-cells continuously and stored up in the gall-bladder, and during digestion is poured out into the upper part of the small intestine. Its action is chiefly in aiding the emulsification of fats; antiseptic, preventing putrefaction in intestines, and stimulating peristalsis. The part of the bile that is an excretion contains an excrementitious substance, cholesterin. It is found most abundantly in nerve tissue and in the brain, and is effete matter resulting from the normal action and wear of the tissues. It is, of course, taken up by the blood and lymphatics, carried to the liver, and there excreted in the bile, by which it is carried to the intestines and discharged from the body in a modified form.

Digestion.

Intestinal Digestion.—When the chyme begins to pass from the pyloric end of the stomach, the upper portion of the small intestine begins a peristaltic motion and intestinal digestion begins. The food thus passes quickly from a digestive fluid that is acid in reaction to one that is alkaline. The serous coat of the intestines secretes a lubricating fluid that facilitates the peristaltic contraction of the muscular coat, and the mucous membrane secretes part of the intestinal juice and mucus and contains glands, villi, lymphatics, and blood-vessels, by which the digested food is absorbed. At about the middle of the duodenum, which is the uppermost part of the small intestine, the common bile-duct and the pancreatic duct enter and pour into the intestines, the one the bile from the liver and the other the pancreatic juice from the pancreas. Intestinal digestion proper begins when the chyme enters the small intestine, where it becomes mixed with the intestinal juice.

The pancreatic juice is composed of water, organic substances, proteids, inorganic salts, and is alkaline in reaction. The three enzymes, or organic substances in the pancreatic juice, are the most important constituents, and are (1) the proteolitic enzyme, trypsin, (2) amylopsin enzyme, (3) the fat-splitting or emulsifying enzyme, steapsin. The trypsin acts on the proteids and albuminoids, carrying them through the same stages of digestion as the gastric juice. The amylopsin acts upon

the starches in exactly the same manner as the saliva does, converting them first into dextrose, then into maltose, and as such they are absorbed. The steapsin acts entirely upon the fats as a splitting agent by adding water to them (hydrolysis); this liberates the fatty acid and glycerine; then these acids combine with the alkaline salts in the intestines and form soap, which in turn aids and hastens the emulsification of the fats. Fats are absorbed into the general system in the form of an emulsion.

The biliary secretion is a yellow liquid which is strongly alkaline, due to the sodium salts that it contains. Upon the proteids and fats it has no direct action, but the sodium salts join with the fatty acids, forming soap, and thereby indirectly aid in the digestion of fats. Upon the carbohydrates the intestinal juice has an important action, aiding the amylopsin of the pancreatic juice in changing sugar into dextrin. The secretion of the large intestine consists principally of mucus, is alkaline, and has no digestive qualities at all. The mucous membrane of the large as well as the small intestine acts as an absorbing medium of the digested food, water, etc. In the case of nutritive enemata thrown into the large intestine, unless they are pre-digested artificially, they will not be readily absorbed.

THE ACTION OF BACTERIA OF THE GASTRO-INTESTINAL TRACT.—Normally this tract contains many different kinds of bacteria, some acting to cause putrefaction of proteids, and others acting to cause fermentation of the carbohydrates. Normally in the stomach the acid prevents completely the action of these bacteria on the proteids and greatly diminishes it upon the carbohydrates. In the intestines all of the normal secretions are alkaline. Pathologically these bacteria act and produce all kinds of stomach and intestinal trouble, such as fermentative dyspepsia, summer complaint of children, and many other irritating troubles.

Before going further into the subject of digestion, I think it proper to say a few words concerning enzymes, which are the main factors in this process. An enzyme is an unformed or unorganized ferment named thus to distinguish it from the organized living ferments, such as bacteria and the yeast plant. Its exact chemical composition is not exactly known, but all the enzymes contain nitrogen and are very soluble in water and glycerin; and it is in solution in these fluids that we obtain them from the glands that manufacture them. They are classified according to the reaction that they produce, viz.: proteolytic, those acting on proteid foods, changing them into peptones, e. g., pepsin and trypsin; amylopytic, those acting on carbohydrates or starchy foods, converting them into sugar, e. g., ptyalin and amylopsin. There is

another kind of enzyme with a kindred action, invertin, which changes what are known as double sugars into single sugars. Fat-splitting enzymes are those which have the power of splitting up the fat globules. Steapsin of the pancreatic juice is an example. Coagulating enzymes are those which act on the soluble proteids, converting them into insoluble ones, e. g., thrombin formed in shed blood and rennin of the gastric juice. Temperature of 160 to 175° F. destroys the action of enzymes. The enzymes all act alike,—that is, in some way they cause the molecule of the substance acted on to take up water, thus splitting and disassociating it, forming simpler substances.

Absorption.

Food products which have been digested are absorbed by one of two routes, viz., they pass directly into the intestinal lymphatics known as lacteals, or they may be absorbed by the process of osmosis. Exosmosis is when the flow tends to go out, and endosmosis is when the flow is towards the inside. Albumins dialyze very slightly. In the alimentary tract we have, then, mucous membrane as the dialyzing membrane, with the blood and lymph on the one side of it and the digested food on the other. The fact that the blood is quickly flowing hastens endosmosis, as it prevents the establishment of equilibrium.

Absorption by the Stomach.—Water is practically not absorbed at all; salt, unless in three per cent. solution, very slightly; alcohol, very readily; sugars and proteids, when concentration has reached five per cent., slightly; fats, not at all.

Absorption in Small Intestine.—Sugars, peptones, proteose, and fats, as well as water and salts, are principally absorbed here. The absorption of these substances may be explained by osmosis, but it is to a great extent accomplished by some power possessed by the living cell, by which the digested substances are taken up and then transferred to the blood or the lymph. There is considerable absorption accomplished in the large intestine in the same manner, and all or very near all that is not absorbed here is destroyed by the bacteria.

As we have spoken of food stuffs, we will now say a few words about the absorption of these substances into the circulating fluids of the body and their final assimilation by the living cell. The proteids, after having been digested or changed into proteoses, are absorbed directly into the blood by a process, the exact character of which is not known, of the living epithelial cell lining the gastro-intestinal tract. This absorption takes place largely in the small intestine, and but slightly in the stomach and large intestine. Carbohydrates are absorbed in the same manner by the blood-vessels of the small intestine. Water and salts principally

by the blood-vessels, but partly by the lymphatics of the intestines, and slightly by the stomach and large intestine. Fats are absorbed by the lymphatics of the small intestine entirely. The proteids and carbohydrates are taken into the blood of the portal vein, carried to the liver, and there acted upon again by an enzyme and converted into glycogen. The fat does not go to the liver directly, but is taken by the lymphatics to the thoracic duct, and from this duct it is emptied into the general circulation at the junction of the left subclavian and internal jugular veins.

LIVER.

The liver is the largest glandular organ in the body, weighing from three to eight pounds, and lying for the most part in the right hypochondriac region, but extending to the left of the median line. The liver is composed of many little cells, which are in irregular clusters the size of a mustard-seed and form the liver lobules. Each lobule is supplied by blood coming in part from the portal vein and in part from the hepatic artery. The one comes from the digestive tract loaded with the digested food, and the other loaded with pure arterial blood from the left ventricle. Each lobule in addition gives rise to the bile-vessels or capillaries, which take up the bile formed by the cells and carry it to the gall-bladder. Thus we find that the physiological function of the liver resolves itself into two parts, (1) the production of the bile, and (2) the metabolic changes produced in the mixed blood of the portal vein and hepatic artery as it flows through the lobule and bathes the liver-cells. Here we have to deal principally with the formation of urea and glycogen.

BILE.

A liquid in varying color from a yellowish brown to sometimes a greenish tint. The yellow is due to the coloring matter, bilirubin, found mostly in carnivorous animals, and the green tint is due to biliverdin, found in herbivorous animals. These are for the most part excreta.

The bile is alkaline and contains two acids, viz., glycocholic and taurocholic, which exist in combination with soda, as a glycocholate or taurocholate of soda, and not as free acid. It likewise contains cholesterin, a non-nitrogenous substance, not formed by the liver-cells, but eliminated from the blood by them and excreted into the intestinal tract. Lecithin, another ingredient of the bile, is probably a waste product originating in nerve-tissue change. The physiological function of the bile is twofold, viz., (1) as an excretion, in eliminating bilirubin and biliverdin, lecithin, cholesterin, and bile acids; (2) as a secretion, by which function it aids in splitting up and emulsifying fats, in pre-

venting to a certain extent the putrefaction, indirectly, of proteids, and in neutralizing and rendering alkaline, with the other intestinal juices, the acid chyme coming from the stomach, and thereby aiding digestion. The secretion of the bile is constant, but the flow into the intestinal tract is intermittent, being stored up in the gall-bladder between times of digestion.

The second function of the liver is that of the formation of urea and glycogen. As to formation of the urea by the liver we will say little, except that it has been proven that after the stages of metabolism have been gone through with, urea is formed from the proteid substances taken in the food. It has also been proven that urea is formed in the liver, and that the blood takes it up from the liver and carries it to the kidneys, where it is excreted in the urine.

We have seen that the carbohydrates when absorbed as dextrose are carried by the blood of the portal vein to the liver, where the dextrose is converted by the liver-cells into glycogen, which is a substance having the same chemical composition as the starches and is called animal starch. The glycogen is stored up in the liver-cell to await the necessities of the system. It is likewise found to be produced and stored to a great extent in muscular tissue, and, in fact, to a certain extent in many other tissues. The fact has also been discovered that when there is an excess of animal heat formed either pathologically or by muscular exercise, the stored-up supply of glycogen, muscle, etc., is quickly exhausted, unless carbohydrates are taken in the food. This proves that carbohydrates are taken into the body to produce animal heat, being converted first into glycogen by the liver-cells, then, strange to say, again into dextrose, and as such are taken up by the living cell and oxydized, thus forming animal heat, carbonic acid gas, and water. The carbonic acid gas is thrown off by the lungs and skin, and the water by the kidneys and bronchial tubes and sweat-glands. Thus we have seen the start and finish of the food stuff through the system. The fats are either utilized to form animal heat and muscular energy, forming carbonic acid gas and water, or are stored up in the body and utilized when there is an over-demand. When the peptones reach the liver-cells through the portal vein there is probably an action on them by the cells, and this action in a way converts them into simpler forms of substances, so that they may be more readily utilized by the tissues.

(The end.)